Characterization of barriers and facilitators for adequate and healthy eating in the consumer's food environment

Caracterização das barreiras e facilitadores para alimentação adequada e saudável no ambiente alimentar do consumidor

Caracterización de las barreras y facilitadores para una alimentación adecuada y saludable en el entorno alimentario del consumidor

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Abstract

This study aims to explore potential barriers and facilitators for healthy eating in the consumer food environment, and to analyze the association with different types of food retailers, having as theoretical reference the Dietary Guidelines for the Brazilian Population. *This is a cross-sectional study carried out in the municipality of Jundiaí, São Paulo State, Brazil, with audits of the consumer food environment carried out in 650 retail stores. We identified barriers and facilitators of healthy food choices in the internal environment of the retail. Factor analysis estimated factors that characterized the environment according to barriers and facilitators. Linear regression evaluated the association between the factors and the different categories of establishments. Most establishments had priority sales of ultra-processed products. Out of the total food retailers studied, 75.9% offered sugary drinks; 37% rice, beans and 30% fruits and vegetables. We characterized the first factor by the presence of both barriers and facilitators (mixed factor), the second factor by more facilitators and the third by greater presence of barriers in the consumer environment. Supermarkets were positively associated with the three factors (p-value < 0.001). The fruit and vegetable stores and the neighborhood markets had a positive association with the most facilitating factor (p-value < 0.001). Markets and bakeries were positively associated with the more barriers factor (p-value < 0.001). The patterns that characterize barriers and facilitators for healthy eating differ significantly according to types of food retailers.*

Food Supply; Healthy Diet; Environmental Health

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Introduction

The food environment refers to the physical, economic, political and sociocultural context in which consumers interact with the food system to acquire, prepare and consume food [1]. The conditions and characteristics of this environment influence the choices and life habits of individuals, and this can be considered an obesogenic environment and favor the development of obesity [2]. There are several national [3,4,5,6] and international [7,8,9,10] studies that explore the complex relationship between the different environmental determinants and health-related outcomes, such as physical activity, food consumption and obesity.

One of the conceptual models developed to support the understanding of the complexity of environmental determinants and their relationship with food consumption was built by Glanz et al. [9] and divides the food environment into four dimensions: community, consumer, organizational and information. All these dimensions are influenced by public policies and by the private sector, shaping the population's eating patterns. A literature review also performed by Glanz et al. [8] showed that most of the studies using the model cited are on the community food environment with a focus on the presence, density and type/category of commercial food establishments and their relationship with obesity and food consumption [7,8,11]. A smaller number of studies explore the relationships between the consumer's food environment with diet and obesity [7]. The consumer environment is the space where people acquire food and at the same time are exposed to factors that can positively or negatively influence food choices [1,8,12,13,14]. Among these factors are the availability of food, variety, quality, price, sale, advertising, location of products on the shelves, organization of physical space and nutritional information [7].

In the consumer food environment, the use of strategies such as increasing supply and variety of healthy foods at affordable prices [15], making fruits and vegetables available at the store entrance and or at strategic positions [16], carrying out promotional pricing for healthy foods and reducing advertisements for unhealthy foods seem to act as facilitators for healthier food choices [8,12,17,18]. On the other hand, the most common barriers found in literature that manipulate the purchase behavior and force the consumer to acquire unplanned foods [19] are: the presence of publicity and promotions with ultra-processed foods [20], the use of sophisticated marketing skills to influence the consumer (for example, ensuring the circulation throughout the store so that the consumer goes through all sections, including islands and displays with ultra-processed foods, making ultra-processed foods available in the cashier lines), offering tastings of foods [21], allowing suppliers of ultra-processed foods to pay for privileged spaces inside the stores and increasing the space in the shelves for unhealthy foods or positioning them at eye-level [16].

The presence of facilitators and barriers to healthy food choices differ according to types of food retailers. In the United States, grocery stores or small retails (equivalent to neighborhood markets in Brazil), are associated with better availability of healthy foods than those named corner stores (equivalent to our convenience stores) [22]. In supermarkets the findings are divergent. In Australia, a study has identified that supermarkets can market healthy foods in variety, but their shelves and marketing strategies emphasize ultra-processed foods, which, despite being profitable for retailers, does not comply with food guidelines that recommend the consumption of *in natura* or minimally processed foods [16]. In the United States [23], the Netherlands [24] and Brazil [25], flyers available in supermarkets with food promotions and advertising are dominated by ultra-processed foods compared to *in natura* or minimally processed foods. In other regions of the world, the presence of fresh food in supermarkets is associated with a lower prevalence of obesity compared to areas served only by local markets with more restricted options available [26,27].

In Brazil, although two important studies with representative samples of the population identify that the main place of food acquisition among Brazilians is the supermarket [28,29], we have in the national territory different types of shops where food sales occur, such as supermarkets, hypermarkets, wholesalers, markets, grocery stores, convenience stores, bakeries, butchers, fish shops, fruit and vegetable stores and greengrocer. These establishments differ in terms of the nature of the products marketed, size and physical structure [30]. Brazilian studies suggest that food retailers are associated with the consumption of fruits and vegetables as well as sugary drinks and ultra-processed

foods [5,31], and among the environmental factors that lead to these findings are food availability, price and advertising.

On the national scenario, where the population has been increasingly purchasing and consuming ultra-processed foods [32] and with a higher prevalence of obesity [33], understanding the barriers and facilitators to healthy food choices present in the consumer environment may help identify the locations that increase the supply of healthy foods, to assist in understanding the environmental factors related to obesity and guide the population in their process of acquiring food [34]. Considering that, this study aims to explore potential barriers and facilitators for healthy eating in the consumer food environment and analyze the association with different types of food retailers, having as theoretical reference the *Dietary Guidelines for the Brazilian Population* [35].

Methods

Study design and sample

This is a cross-sectional study conducted in the municipality of Jundiaí, São Paulo State, Brazil. An audit of the consumer food environment was conducted between the months of December 2017 to April 2018 in virtually the entire urban territory of the municipality. To get a general overview of this environment, first, all 624 urban census sectors of Jundiaí were identified and mapped. Of these, 92% (n = 573) were covered by the researchers and only 8% (n = 51) were not, due to difficulty of access or issues of urban violence. Among the census sectors covered, 650 food retailers were identified, and the internal audit of the establishment was carried out in all of them. All retail businesses that participated in the study received information and signed the Informed Consent Form. The study was approved by the Research Ethics Committee of the School of Public Health, University of São Paulo (CAAE: 69045917.5.0000.5421).

Audit of the consumer food environment and classification of retail trades

The audit was carried out by six researchers trained according to a previously published field manual [36]. The training lasted 6 hours, allowing the presentation of the healthy eating guidelines proposed in the *Dietary Guidelines for the Brazilian Population* [35]. The instrument used in the data collection was AUDITNOVA (https://nutritotal.com.br/pro/material/audit-nova/), a checklist-type instrument that allows collecting information on availability, variety and price (normal or in sales) of 66 foods and beverages, as well as advertising strategies, information and positioning of *in natura* or minimally processed foods, culinary ingredients, processed foods and ultra-processed foods according to the new food classification [37]. Details on the process of validation and reliability assessment of this instrument are in a previous publication [38].

The 650 food retailers identified in the audit were grouped into 6 categories adapted from Machado et al. [31] and Castro Junior [39]: (1) butcher/fish shop/slaughterhouses, (2) public and private fruit and vegetable stores, (3) neighborhood markets, (4) supermarkets, (5) bakeries, (6) trade with priority sale of ultra-processed products (consisting of corner stores, sweets and treats stores, pharmacies, food supplement stores and trade in beverages).

Construction of the variables barriers and facilitators

From the information present in the AUDITNOVA instrument, it was possible to create variables that were classified as barriers and facilitators for healthy eating in the consumer food environment, which were in dialogue with literature review studies on the subject [8,40,41] and also with the obstacles to achieve adequate and healthy eating present in the *Dietary Guidelines for the Brazilian Population* [35], in particular cost, information and advertising. Therefore, after this process, the dimensions considered for both barriers and facilitators were: advertising, information, physical modifications in the layout of the establishment, promotional pricing and availability. Table 1 shows in detail all the items included in the construction of each variable, as well as the dimensions analyzed.

Table 1

Characterization of barriers and facilitators for healthy food choices in the consumer's food environment. Jundiaí, São Paulo State, Brazil.

Items that make up the variable (AUDITNOVA)	Minimum number of items	Maximum number of items
Facilitators for healthy eating		
Advertising of *in natura* or minimally processed foods and culinary ingredients		
Advertising in the cash register (yes or no)	0	12
Advertising with appeal to functional property of food (yes or no)	0	12
Advertising with appeal to physical activity (yes or no);	0	12
Advertising with appeal to well-being, good humor, self-esteem (yes or no)	0	12
Advertising with health claim (yes or no)	0	12
Advertising with appeal to practicality (yes or no)	0	12
Advertising of the kind buy 3, pay for 2 (yes or no)	0	12
Advertising with appeal to organoleptic properties (yes or no)	0	12
Advertising for product launch (yes or no)	0	12
Advertising with tying sales (yes or no)	0	12
Advertising around the establishment (yes or no)	0	12
Advertising of culinary ingredients around the establishment (yes or no)	0	12
Information about *in natura* or minimally processed foods		
Flags (yes or no)	0	4
Banners, posters, and flyers (yes or no)	0	4
Tabloids (yes or no)	0	4
Folder/brochures with recipe information (yes or no)	0	4
Physical changes promoting *in natura* or minimally processed foods		
Fruits and vegetables at the entrance to the store (yes or no)	0	3
In natura or minimally processed foods available in the cash register (yes or no)	0	3
Displays with *in natura* or minimally processed foods (yes or no)	0	3
Promotional pricing of *in natura* or minimally processed foods, culinary ingredients, and processed foods		
Promotional price for the following foods (yes or no): orange, banana, papaya, apple, watermelon, other fruits, tomato, onion, lettuce, carrot, zucchini, chayote, parsley, other vegetables, potato, cassava, other roots, corn cob, white egg, other eggs, prime meat, secondary cuts, whole chicken, chicken breast, bacon, dried meat, fish, milk, butter, cheese, pinto beans, black beans, white rice, wheat flour, pasta, cassava flour, raw peanuts, oil, olive oil, salt, crystal sugar, refined sugar, canned corn, tomato extract, canned sardines, bread roll	0	46
Availability of *in natura* or minimally processed foods, culinary ingredients, and processed foods		
The following foods are available (yes or no): range, banana, papaya, apple, watermelon, other fruits, tomato, onion, lettuce, carrot, zucchini, chayote, parsley, other vegetables, potato, cassava, other roots, corn cob, white egg, other eggs, prime meat, secondary cuts, whole chicken, chicken breast, bacon, dried meat, fish, milk, butter, cheese, pinto beans, black beans, white rice, wheat flour, pasta, cassava flour, raw peanuts, oil, olive oil, salt, crystal sugar, refined sugar, canned corn, tomato extract, canned sardines, bread roll	0	46

(continues)

Table 1 (continued)

Items that make up the variable (AUDITNOVA)	Minimum number of items	Maximum number of items
Barriers to healthy eating		
Advertising of ultra-processed foods		
Advertising of ultra-processed food in the cash register (yes or no)	0	11
Sample giveaway (yes or no)	0	11
Advertising with appeal to health and well-being (yes or no)	0	11
Advertising with appeal to practicality (yes or no)	0	11
Advertising with appeal to functional aspects (yes or no)	0	11
Advertising of the kind buy 3, pay for 2 (yes or no)	0	11
Advertising with appeal to organoleptic properties (yes or no)	0	11
Advertising with product launches (yes or no)	0	11
Advertising with tying sales (yes or no)	0	11
Advertising of processed food around the establishment (yes or no)	0	11
Advertising of ultra-processed food around the establishment (yes or no)	0	11
Information in general		
Presence of magazines on diets, foods, recipes (yes or no)	0	3
Presence of tabloids of offers (yes or no)	0	3
Presence of folders or brochures (yes or no)	0	3
Physical modifications promoting ultra-processed foods		
Ultra-processed foods available in the cash register (yes or no)	0	5
Tasting counter with ultra-processed foods (yes or no)	0	5
Displays with ultra-processed foods (yes or no)	0	5
Islands with ultra-processed foods (yes or no)	0	5
Aisles extremities with ultra-processed foods (yes or no)	0	5
Promotional pricing of ultra-processed foods		
Promotional price for the following foods (yes or no): sausage, dairy beverage, instant noodles, ready-made seasoning, bread loaf, breakfast cereals, ready-made pizza, ice cream, canned soft drink, 2-liter bottle soft drink, diet/light soft drinks, nectar, squash, corn chips, sandwich biscuit, chocolate and candies	0	18
Availability of ultra-processed foods		
The following foods are available (yes or no): sausage, dairy beverage, instant noodles, ready-made seasoning, bread loaf, breakfast cereals, ready-made pizza, ice cream, canned soft drink, 2-liter bottle soft drink, diet/light soft drinks, nectar, squash, corn chips, sandwich biscuit, chocolate and candies	0	18

In AUDITNOVA, the items that contemplate these dimensions are all dichotomous (with yes =1 and no = 0 answers). To create quantitative variables, the items were then added together for each of the barriers and facilitators studied.

The facilitators were built in the following quantitative variables: the advertising of *in natura* or minimally-processed foods, culinary ingredients; Information about *in natura* or minimally processed foods; Physical changes promoting *in natura* or minimally-processed foods; Promotional pricing of *in natura* or minimally-processed foods, culinary ingredients and processed foods; Availability of *in natura* or minimally-processed foods, culinary ingredients and processed foods. The construction of these indicators was guided by the *Dietary Guidelines for the Brazilian Population* [35], which recommends that the basis of food be composed of *in natura* or minimally processed foods and their culinary preparations, supplemented with small amounts of processed foods.

As barriers, the following continuous variables were created: advertising of ultra-processed foods; information in general; physical modifications promoting ultra-processed foods; promotional pricing of ultra-processed foods; availability of ultra-processed foods.

To create the variables on information, the main formats in which advertising messages and information on foods are available in the food retailers were considered (such as: posters, banners, flags, tabloids, flyers with recipes and magazines); for the advertising variable, the main consumer appeals were considered (example: health and well-being claim, practicality, practice of physical activity, among others); for the variable physical modifications, the main changes in the layout were considered to promote the sale of food (example: presence of food in the cash register, fruits and vegetables at the entrance of the store, displays and islands in the aisles of shops); and to create the variable promotional pricing, we considered if the food studied had a promotional price at the time of the audit (Table 1).

Statistical analysis

Analyses with descriptive statistics were used to characterize and explore the food retailers analyzed in the study. The means and the respective 95% confidence intervals (95%CI) were calculated for each variable considered facilitator and barrier to healthy choices, according to different categories of commercial establishment. To evaluate the differences in the variables barriers and facilitators according to the establishment category, an analysis of variance (ANOVA) was performed at a 95% confidence level.

Exploratory factor analysis was used to identify groups within the evaluated data that allowed to characterize the occurrence of barriers and facilitators of healthy eating in the consumer's food environment. Factor analysis is especially interesting to identify latent variables from the studied data set [42]. The exploratory approach was chosen in the absence of an a priori understanding of what would be the possible combinations between facilitators and expected barriers in different categories of food retail trades. The analytical model included all 5 variables defined as barriers and 5 defined as facilitators in the form of continuous quantitative variables.

The Kaiser-Meyer-Olkin index (KMO) above 0.60 and the Bartlett's test of sphericity (BTS) with a p-value below 0.05 were used to evaluate the adequacy of the sample and verify the applicability of the data for factor analysis [42]. After these procedures, exploratory factor analysis was performed (following the principal component factor extraction method) with orthogonal rotation of the *varimax* type. Each factor generated in the factor analysis represented a linear combination of the variables that entered the model. Variables with factor loads > 0.30 were considered important constituents of this factor [42]. Positive factor loads (> 0.30) indicate positive correlations between the variables and the factors obtained, while negative factor loads (> -0.30) indicate negative correlations.

To decide the number of factors to be retained by factor analysis, the following criteria were used: eigenvalues > 1, graphic interpretation of the Cattel or scree plot graphic test (observing the maximum point of inflection of the line) and interpretation of factor loads. After extraction of the main factors, standardized scores of each of them were calculated for each commercial establishment of the study.

Univariate linear regression analysis was used to evaluate the association between each of the factors (outcome) and the categories of food retailers studied (exposure). Positive associations show greater adherence of trade to certain set of barriers and facilitators, while negative associations show less adherence. All analyses were conducted in the statistical package Stata version 15 (https://www.stata.com). Values of p < 0.05 were considered significant.

Results

Of the 650 food retailers audited in the municipality of Jundiaí, 43.9% had a priority sale of ultra-processed products, 25.2% as neighborhood markets, 14.5% as bakeries, 5.9% butchers/fish shops/slaughterhouses and 5.9% as public and private fruit and vegetable stores (Table 2). In general, establishments offer a variety of *in natura* or minimally processed foods, culinary ingredients, processed foods and ultra-processed foods. Among the ultra-processed foods available, there was a high prevalence of establishments with the presence of sugary drinks (75.9%), candies, chocolates and sandwich cookies (74.8%), corn chips (59.1%) and ice cream (53.2%). On the other hand, there was also a high

Table 2

Characterization of food retailers according to food type and availability. Jundiaí, São Paulo State, Brazil.

Variables	n	%
Establishment category		
Butcher/Fish shop/Slaughterhouses	38	5.9
Public and private fruit and vegetable stores	38	5.9
Neighborhood markets	164	25.2
Supermarkets	31	4.8
Bakeries	94	14.5
Trade with priority sale of ultra-processed	285	43.9
Available food (percentage of establishments) *		
Fruits (orange, banana, papaya, apple, watermelon, other fruits)	201	30.9
Vegetables (tomato, onion, lettuce, carrot, zucchini, chayote, parsley, other vegetables)	218	33.5
Roots and tubers (potato, cassava, other roots)	200	30.8
Eggs	245	37.7
Beef	129	19.9
Chicken	147	22.6
Fish	109	16.9
Beans	242	37.2
Rice	246	37.9
Water	518	79.7
Culinary ingredients (oil, olive oil, salt, crystal sugar, refined sugar, butter)	361	55.5
Bread roll	259	39.9
Ultra-processed meats (sausages)	232	35.7
Dairy beverages	123	18.9
Instant noodles	295	45.4
Ready-made seasoning	211	32.5
Bread loaf	242	37.2
Breakfast cereal	114	17.5
Ready-made pizza	95	14.6
Ice cream	346	53.2
Candies, chocolates, and sandwich cookies	486	74.8
Sugary drinks	493	75.9
Corn chips	384	59.1

* The food retailers that had at least 1 type of food in the food groups studied available were counted.

availability of culinary ingredients (55.5%), rice and beans (approximately 37.0% each), fruits, vegetables, roots and tubers (approximately 30% each) and water (79.7%) (Table 2).

Regarding the facilitators for healthy food choices, the supermarkets had, on average, more advertising of *in natura* or minimally-processed foods and culinary ingredients; more information on *in natura* or minimally-processed foods and promotional pricing of *in natura* or minimally-processed foods, culinary ingredients and processed foods, and more availability of *in natura* or minimally-processed foods, culinary ingredients and processed foods (p-value < 0.05). Public and private fruit and vegetable stores showed on average more physical modifications that promote the sale of food *in natura* or minimally processed (p-value < 0.001). However, it was also possible to observe that fruit and vegetable stores and neighborhood markets, along with supermarkets, were the three categories of establishment with the highest availability of *in natura* or minimally processed foods, culinary ingredients and processed foods (Table 3).

Table 3

Mean (95% confidence interval – 95%CI) of the variables characterized as facilitators and barriers according to type of commercial establishment. Jundiaí. São Paulo State. Brazil.

Variables	Butchers	Fruit and vegetable stores	Neighborhood markets	Super-markets	Bakeries	Trade with priority sale of ultra-processed products	p-value *
	Mean (95%CI)	Mean (95%CI)	Mean (95%CI)	Mean (95%CI)	Mean (95%CI)	Mean (95%CI)	
Facilitators for healthy eating **							
Advertising	0.2 (0.0; 0.3)	0.5 (0.2; 0.7)	0.3 (0.1; 0.4)	1.2 (0.7; 1.7)	0.0 -	0.0 (0.0; 0.1)	0.000
Information	0.1 (0.0; 0.2)	0.5 (0.4; 0.7)	0.5 (0.4; 0.6)	1.3 (1.0; 1.6)	0.0 (0.0; 0.1)	0.0 -	0.000
Physical modifications	0.3 (0.1; 0.5)	2.0 (1.7; 2.3)	1.0 (0.9; 1.1)	1.0 (0.7; 1.3)	0.1 (0.0; 0.2)	0.1 (0.0; 0.1)	0.000
Promotional prices	0.8 (0.2; 1.5)	0.6 (0.2; 1.0)	1.1 (0.6; 1.5)	7.5 (5.3; 9.8)	0.1 (0.0; 0.1)	0.0 -	0.000
Food availability	11.6 (8.9; 14.2)	19.3 (16.1; 22.6)	26.5 (24.8; 28.3)	38.0 (33.5; 42.5)	9.2 (8.0; 10.5)	1.0 (0.7; 1.3)	0.000
Barriers to healthy eating ***							
Advertising	1.6 (1.0; 2.1)	1.2 (0.6; 1.8)	3.0 (2.7; 3.2)	5.2 (4.2; 6.2)	2.7 (2.4; 3.1)	2.1 (1.9; 2.4)	0.020
Information	0.1 (0.0; 0.2)	0.0 -	0.1 (0.0; 0.1)	0.7 (0.4; 1.0)	0.1 (0.0; 0.1)	0.1 (0.1; 0.1)	0.000
Physical modifications	1.4 (1.1; 1.8)	1.3 (0.9; 1.7)	2.7 (2.6; 2.8)	3.6 (3.4; 3.9)	2.3 (2.2; 2.5)	1.8 (1.7; 2.0)	0.000
Promotional prices	0.3 (0.1; 0.6)	0.0 -	0.7 (0.4; 1.1)	6.1 (4.1; 8.1)	0.0 (0.0; 0.1)	0.1 (0.1; 0.2)	0.000
Food availability	6.4 (5.0; 7.8)	5.0 (3.0; 7.1)	13.3 (12.6; 13.9)	16.8 (15.7; 17.9)	9.7 (9.0; 10.3)	4.1 (3.6; 4.5)	0.000

* ANOVA;

** In this case the variables considered were related to *in natura* or minimally processed foods, culinary ingredients, and processed foods;

*** In this case the variables considered were related to ultra-processed foods.

Regarding barriers, supermarkets and neighborhood markets have, on average, more advertising of ultra-processed foods, physical modifications in the environment that promote ultra-processed foods, promotional pricing of ultra-processed foods and greater availability of ultra-processed foods, compared to other categories of establishments. It is noteworthy that fruit and vegetable stores showed the lowest averages for barriers such as advertising, information, physical modifications and promotional pricing of ultra-processed foods (p-value < 0.05) (Table 3).

Regarding the characterization of the consumer's food environment through factor analysis with the barriers and facilitators of food choices, we were able to verify three main factors, which explained 71.9% of the total variance of the data. We characterized the first factor by the presence of both barriers and facilitators (hereinafter called the mixed factor), the second factor by the greater presence of facilitators (more facilitators) and the third factor had a greater presence of barriers in the consumer environment (more barriers) (Table 4).

Table 4

Factor loads, explained variance and eigenvalues of the three main factors that characterized barriers and facilitators for food choices in the consumer's food environment. Jundiaí, São Paulo State, Brazil.

Variables	Factor 1 (mixed)	Factor 2 (more facilitators)	Factor 3 (more barriers)
Advertising of *in natura* or minimally processed foods and culinary ingredients	0.67	0.34	-0.04
Information about *in natura* or minimally processed foods	0.46	0.68	0.20
Physical changes promoting *in natura* or minimally processed foods	0.04	0.84	0.00
Promotional pricing of *in natura* or minimally processed foods, culinary ingredients, and processed foods	0.80	0.29	0.21
Availability of *in natura* or minimally processed foods, culinary ingredients, and processed foods	0.23	0.76	0.50
Advertising of ultra-processed foods	0.31	-0.03	0.75
Information in general	0.69	-0.22	0.26
Physical modifications promoting ultra-processed foods	0.12	0.13	0.85
Promotional pricing of ultra-processed foods	0.79	0.20	0.35
Availability of ultra-processed foods	0.09	0.52	0.75
Explained total variance	25.65	23.19	23.10
Eigenvalues	4.53	1.40	1.26
Kaiser-Meyer-Olkin	0.80	-	-

Table 5 shows the β-coefficients (95%CI) between the categories of food retailers and the mean score of the factors found. Supermarkets had a positive association with the mixed factor and neighborhood markets and bakeries had a negative association. Public and private fruit and vegetable stores, neighborhood markets and supermarkets had a positive association with the factor more facilitators, while bakeries and businesses with priority sale of ultra-processed foods had a negative association (p-value < 0.001). Finally, supermarkets, bakeries and neighborhood markets showed a positive association (p-value < 0.001) with the factor more barriers, and butchers/fish shops/refrigerators (p-value < 0.01) and fruit and vegetable stores a negative association (p-value < 0.001).

Discussion

The study advanced in the identification of facilitators and barriers to food choices in the consumer environment, which differ significantly between the categories of establishments studied. We also identified that the availability of food in the municipality is varied, although the presence of ultra-processed products prevails. Approximately 70% of businesses sell sugary drinks and treats, against approximately 35% that sell rice, beans, fruits and vegetables, foods recommended for a healthy diet in Brazil [35]. The exploration of factors that characterize the consumer environment in relation to the presence of barriers and facilitators for healthy food choices revealed three distinct patterns: (1) factor that shows advertising, information and promotional pricing for both healthy and unhealthy foods; (2) factor that shows advertising, information, physical modifications, promotional pricing and availability aimed at promoting healthy foods; and (3) factor that shows advertising, information, physical modifications, promotional pricing and availability aimed at promoting unhealthy foods. Among the categories of establishments studied, we positively associated public and private fruit and vegetable stores, neighborhood markets and supermarkets with the factor more facilitators, however, we also verified positive associations of supermarkets and neighborhood markets to the pattern more barriers, showing that within the same category of establishments we can have different forms of advertising, availability, information, physical modifications and promotional pricing.

Table 5

Association between the three main factors and types of food retailers. Jundiaí, São Paulo State, Brazil.

Type of commercial establishment	Factor 1 (mixed) β-coefficients (95%CI)	Factor 2 (more facilitators) β-coefficients (95%CI)	Factor 3 (more barriers) β-coefficients (95%CI)
Butcher/Fish shop/Slaughterhouses	0.09 (-0.23; 0.42)	-0.07 (-0.40; 0.25)	-0.53 (-0.86; -0.21) *
Public and private fruit and vegetable stores	-0.12 (-0.45; 0.21)	1.62 (1.31; 1.92) **	-1.25 (-1.56; 0.94) **
Neighborhood markets	-0.34 (-0.52; 0.17) **	1.16 (1.00; 1.31) **	0.72 (0.55; 0.89) **
Supermarkets	2.63 (2.33; 2.93) **	0.97 (0.61; 1.32) **	1.06 (0.70; 1.41) **
Bakeries	-0.39 (-0.60; -0.17) *	-0.43 (-0.65; -0.21) **	0.45 (0.23; 0.66) **
Trade with priority sale of ultra-processed products	-0.02 (-0.18; -0.13)	-1.20 (-1.32; -10.7) **	-0.57 (-0.72; -0.42) *

95%CI: 95% confidence interval.

* $p < 0.01$;

** $p < 0.001$.

In this study we explored characteristics of the consumer's food environment that can act as barriers and facilitators of healthy food choices. The availability of food was one of the aspects studied. There was high availability of ultra-processed foods and beverages, with high energy density, and poor in nutrients [43]. Exploring the relation between the availability and consumption of food and beverages represents an important future theme for consumer food environment research in Brazil and Latin America [4,40,44]. Our data suggest that focusing on improving access to healthy food and beverages only through the physical availability of these foods in retail stores may not be effective, since other factors such as price, advertising, information, and physical modifications interact in the consumer environment.

Higher exposure to ultra-processed foods and beverages, especially soft drinks or sugar-sweetened beverages, in items sold and advertised was more frequent in supermarkets and neighborhood markets. These products have been associated with the appearance of several chronic non-communicable diseases such as obesity, diabetes and coronary heart disease [45,46]. Duran et al. [5] identified an association between a greater variety of sugary drinks sold in retail stores and a 15% increase in the prevalence of their regular consumption (≥ 5 times/week). In addition, the high prevalence of businesses selling these products also reflects considerable effort by large multinational corporations to increase sales of ultra-processed foods in Latin American countries through infrastructure investments, including advertising and physical modifications of the consumer environment [47,48].

The identification and analysis of three possible combinations between barriers and facilitators in different categories of retail trade may bring new elements to underpin future public policies aimed at regulating the food retail sector and promoting healthier food spaces [16]. In addition, including the extent and purpose of food processing among the facilitators and barriers studied helps to bring the consumer food environment closer to the agenda of discussions on public food and nutrition policies in Brazil, since the current epidemiological and nutritional scenario points to an increase in the consumption of ultra-processed foods instead of traditional diet foods [32].

What we currently have in Latin America on consumer food environment are studies that focus especially on assessing food availability and advertising (in general those aimed at children), leaving gaps in the exploration of other factors such as price reduction, physical modifications and information about food [35]. In this sense, this study advances the understanding of three main factors that characterize the consumer's food environment and that can put at risk or protect healthy food choices.

Supermarkets were the only establishment category that showed positive association with all three combinations of barriers and facilitators studied (mixed factor, more facilitators and more barriers). This information is particularly important, since in Brazil 49% of food purchases are made in supermarkets/hypermarkets [29]. According to a study conducted by Machado et al. [28] with data from the 2008/2009 *Brazilian Household Budget Survey*, the share of ultra-processed foods and beverages in purchases made in supermarkets was 25% higher than in other types of food marketing establishments.

In Brazil, studies on the role of supermarkets in promoting healthy eating are divergent. Under consumer perception, a study showed that the wide variety of fresh products available in supermarkets was significantly related to the lower chance of ultra-processed food purchases [49]. Another study, which also investigated the role of food retailers in the acquisition of healthy foods, showed that the prevalence in the regular consumption of produce was lower among low-income individuals and residents of neighborhoods with lower density of supermarkets and markets specialized in the sale of these foods [5].

Public and private fruit and vegetable stores and neighborhood markets showed positive associations with factor 2, which refers to a greater number of facilitators for healthy food choices. In this case, they are places with the presence of advertising, information, physical modifications (ex.: fruit and vegetable section at the entrance to the store), promotional pricing and availability of food recommended by the Dietary Guidelines. Fruit and vegetable stores are equipment already specialized in the sale of healthy foods, and a national study showed that buying in these places increases by 89% the chance of acquiring food *in natura* or minimally processed [49].

The creation of the variables defined as barriers and facilitators for this study allowed to include a good part of the characteristics that influence food purchases in the consumer environment. The use of the AUDITNOVA instrument [38] in the audit process of retail trades facilitated the union of these characteristics into factors. Other instruments validated in Brazil [50,51] include aspects related to the availability, variety and price of food, but do not make it possible to classify them according to the NOVA classification groups [40]. In addition, AUDITNOVA made it possible to explore the presence of advertising and physical modifications from the perspective of facilitators, when promoting *in natura* or minimally processed foods and culinary ingredients, and from the perspective of barriers, when promoting ultra-processed foods. These aspects may contribute to future analyses that aim to monitor the implementation of public policies aimed at regulating the advertising and marketing of ultra-processed foods in the consumer environment.

In Brazil, although the supermarket is the most frequent place of food acquisition among Brazilians [31], other types of establishments should be encouraged, such as the case of public and private fruit and vegetable stores and also butchers, which were associated negatively to factor 3 (greater presence of barriers to healthy choices). Our study analyzed six categories of retail trade in the municipality of Jundiaí, and the most prevalent category was that of trades with priority sale of ultra-processed foods (43.9%), which was associated negatively with the factor more facilitators.

The comparison of the patterns (factors) that characterized the establishments according to barriers and facilitators with other national and international studies is still impractical because, to date, there are no studies that have used this same methodology. However, studies show that the consumer's food environment may contain different barriers that interfere with consumers' food choices and consequently may impact on energy intake [28], the quality of food purchased [31] and the nutritional status of individuals [16].

Recently, a panel of experts organized by Food and Agriculture Organization of the United Nations (FAO) on the role of food environments in food and nutritional security of populations pointed out that restricting the advertising of ultra-processed foods in supermarkets and markets, providing incentives to businesses to make a greater variety of food *in natura* or minimally processed available are key points to improve the food environment, contributing to achieve modern and sustainable food systems [1].

Some strengths of this study are noteworthy. This is an in-depth analysis of the internal environment of food retail stores that were audited face-to-face in a medium-sized municipality in Brazil. The mapping of the establishments present in practically all the urban census sectors allowed to carry out an extensive portrait of the food environment in the territory. Exploratory factor analysis allowed to explore possible combinations of barriers and facilitators (price, availability, information, advertis-

ing and physical modifications) [42]. The use of the AUDITNOVA instrument allowed us to identify in the consumer environment the barriers and obstacles to the achievement of healthy eating present in the *Dietary Guidelines for the Brazilian Population* [35], advancing in relation to studies that evaluate only the availability of food. However, the study also has some limitations, such as not including other food retailers such as restaurants and bars in the audit performed. Every year, the Brazilian population consumes more food outside their home [32], and it is necessary to also investigate the barriers and facilitators present in these environments. The stores of Jundiaí do not represent the sample universe of Brazilian food retailers, so new studies are still needed to improve the variables defined as barriers and facilitators in different geographical and social contexts.

This study showed a more detailed exploration of the consumer's food environment with regard to the presence of barriers and facilitators for healthy eating. The results showed that advertising, information and promotional pricing can, at the same time, form a mixed pattern that on the one hand promotes but on the other hinders healthy food choices, especially among supermarket categories. The internal environment of establishments that market food is still little explored from the point of view of studies on the food environment in Brazil and from the point of view of food and nutrition policies. The aspects explored in this study suggest that, in addition to the availability of food, other factors are important for the population to be able to access healthier foods. These findings may be useful in future research aimed at measuring the relation between aspects of the consumer's food environment and its relation with diet quality and obesity, as well as evaluating the effects of interventions with multiple components in this environment.

Contributors

C. A. Borges contributed to the conception, analysis, data interpretation, writing of the article and responsibility for all aspects of the study. K. T. Gabe collaborated with data analysis and interpretation, critical review of the article. D. S. Canella participated in the critical review of the article, approval of the final version. P. C. Jaime contributed with the critical review of the article, approval of the final version.

Additional informations

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Resumo

O objetivo deste trabalho é explorar potenciais barreiras e facilitadores para alimentação saudável no ambiente alimentar do consumidor e analisar a associação com diferentes tipos de estabelecimentos comerciais tendo como referencial teórico o Guia Alimentar para a População Brasileira. *Estudo transversal realizado no Município de Jundiaí, São Paulo, Brasil, com auditoria do ambiente alimentar do consumidor realizada em 650 comércios varejistas. Foram identificados barreiras e facilitadores das escolhas alimentares saudáveis no ambiente interno dos comércios. Análise fatorial foi utilizada para estimar fatores que caracterizassem o ambiente segundo barreiras e facilitadores. Regressão linear foi utilizada para avaliar a associação entre os fatores e as diferentes categorias de estabelecimentos. A maioria dos estabelecimentos tinham venda prioritária de ultraprocessados. Do total de comércios estudados, 75,9% disponibilizavam bebidas açucaradas; 37% arroz, feijão e 30% frutas e hortaliças. O primeiro fator caracterizou-se pela presença tanto de barreiras quanto de facilitadores (fator misto), o segundo fator caracterizou-se por mais facilitadores e o terceiro por maior presença de barreiras no ambiente do consumidor. Supermercados foram associados positivamente com os três fatores (valor de p < 0,001). Os sacolões/hortifrutis públicos e privados, os mercados de bairro tiveram associação positiva com o fator mais facilitadores (valor de p < 0,001). Os mercados e padarias se associaram positivamente ao fator mais barreiras (valor de p < 0,001). Os padrões que caracterizam barreiras e facilitadores para alimentação saudável diferem de forma significativa segundo tipos de comércios.*

Abastecimento de Alimentos; Dieta Saudável; Saúde Ambiental

Resumen

El objetivo de este trabajo es explorar potenciales barreras y facilitadores para la alimentación saludable en el ambiente alimentario del consumidor, y analizar la asociación con diferentes tipos de establecimientos comerciales, teniendo como referencia teórica la Guía Alimentaria para la Población Brasileña. *Estudio transversal realizado en el Municipio de Jundiaí, São Paulo, Brasil, con auditoría del ambiente alimentario del consumidor, realizada en 650 tiendas minoristas. Se identificaron barreras y facilitadores de las elecciones alimentarias saludables en el ambiente interno de los comercios. El análisis factorial se utilizó para estimar factores que caracterizasen el ambiente según barreras y facilitadores. La regresión lineal se usó para evaluar la asociación entre los factores y las diferentes categorías de establecimientos. La mayoría de los establecimientos tenía una venta prioritaria de ultraprocesados. Del total de comercios estudiados, un 75,9% tenían disponibles bebidas azucaradas; 37% arroz, frijoles y 30% frutas y hortalizas. El primer factor se caracterizó por la presencia tanto de barreras, como de facilitadores (factor mixto), el segundo se caracterizó por más facilitadores y el tercero por una mayor presencia de barreras en el ambiente del consumidor. Los supermercados fueron asociados positivamente con los tres factores (valor de p < 0,001). Las fruterías/verdulerías públicas y privadas, los mercados de barrio presentaron una asociación positiva con el factor más facilitadores (valor de p < 0,001). Los mercados y panaderías se asociaron positivamente con el factor más barreras (valor de p < 0,001). Los patrones que caracterizan barreras y facilitadores para la alimentación saludable difieren de forma significativa según los tipos de comercios.*

Abastecimiento de Alimentos; Dieta Saludable; Salud Ambiental